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the shrill clarion voice of the Downy Woodpecker, you hear a noise like a falling stone through the branches of the tree; it is the shrike: he has struck his victim, and if he does not devour it upon the spot, it is hung on the crotch of a limb to serve as a meal at some future time.

DESMIDS AND DIATOMS.

No. II.

THEIR GROWTH AND GEOLOGICAL IMPORTANCE.

BY PROF. L. W. BAILEY.

[Concluded from page 517.]

IN descending from the study of the higher to that of the lower forms of life, nothing is more remarkable than the manifold and often varied means by which that life is multiplied and perpetuated. In all four departments of the Animal Kingdom this is found to be the case, the higher groups in each producing for the most part a limited number of offspring, which, however, they nurse with proportionate care, while, as we pass to those occupying a lower grade, Nature seems to guard against the extinction of a species by vastly augmenting the reproductive power of the individual. So strikingly is this the case, that fishes, worms, the moss-like mollusca and the polyps, the lower groups under their several types, have been well styled the Embryonic or Reproductive Classes. Nor is this observation true only within the limits of a single department. It is equally the case when one of these classes is compared with another, the difference, however, now appearing not so much in an inequality in the number of actual offspring, as in the introduction of new modes of multiplication, other than the development from eggs. It is true that the numbers of possible young contained in the roe of certain fishes far exceeds anything to be found in the case of either of the classes just alluded to, but of these comparatively few reach maturity; while, slightly among the worms, still more among the flower-like mollusca, and in a most remarkable degree among the coral-polyps, a new mode of reproduction is introduced, by which not mere immature undeveloped individuals only are brought forth, but individuals fully formed, perfect in all their organs, ready to assist at once in the labors of the community of which they form a part.

Hence it is, perhaps, that the lower forms of life have been and are of incomparably more importance than the higher, in modifying the earth's physical features, and in contributing material for its growth. The coral-polyp is a pigmy indeed beside the Mastodon, but while a fragmentary skeleton of the latter is here and there unearthed, the solid framework of the latter has, to a considerable extent, become also the framework of the globe, a portion of the masonry by which, tier upon tier, our continent has risen through successive ages.

In passing from the Animal to the Vegetable Kingdom, the fact to which we have made allusion is equally apparent. Reproduction by *seed*, though the normal, is by no means the only nor indeed the usual method of propagation. Were this the case, and were every form of vegetation but a single individual, how infinitely reduced would be that individual's chances of successfully resisting the thousand accidents to which it is subjected, how infinitely less varied and less beautiful would be the development of vegetable life. But every botanist knows, and every gardener practically proves, that a shrub or tree is not a single indivisible being, but a *community* of individuals, each of them a potential plant, living, it is true, in intimate connection with others of its kind, but equally capable of living alone, when, with proper care, its connection with these latter is severed. Every plant, as it buds in spring, is but reproducing hundreds or perhaps thousands of new individuals, similar in every respect to that which originally sprung directly from the seed. Unlike what is seen in the Animal Kingdom, the higher as well as the lower orders share equally in this peculiar mode of growth; with this difference, however, that while among the higher groups the newly formed parts retain their connections, and become a portion of a compound structure, in the humbler groups they often separate as soon as formed, and acquire a distinct and independent existence.

Let us now observe some of the results of this process, as illustrated in the minute forms of vegetation to which this paper is more especially devoted.

In the last number of the NATURALIST it was shown, that, among the Desmids and Diatoms, though "conjugation" and the formation of seed-like bodies or spores is a normal mode of reproduction, yet here, as among higher plants, multiplication by this method is comparatively unimportant, by far the greater number of individuals arising from the self-division or fission of a single cell. So true is this, indeed, that the former mode, although probably true of all, has as yet been observed in but very few, and those the least remarkable species, while the process of budding or self-division is universal. Indeed, it is scarcely possible to examine a recent gathering of Diatoms, in which individuals will not be found illustrating all the different stages of development, from those in which the "connecting membrane" has merely become slightly enlarged, to those in which it may be seen to contain two new individuals; these latter ready, by the disruption of the membrane, to acquire a separate existence, or, as is more commonly the case, to still maintain some slight connection with the parent cell, thus forming new members in a compound community.

The rapidity of this budding process is something astounding, and goes far to explain the geological importance of these organisms. Ehrenberg, the great microscopic observer, in alluding to this subject, observes that "the silicious infusoria (Diatoms) form, in stagnant waters during hot weather, a porous layer of the thickness of the hand. Although more than 100,000,000 weigh hardly a grain, one may, in the course of half an hour, collect a pound's weight of them; hence it will no longer seem impossible that they may build up rocks;" and Professor Smith, the author of a standard work on these organisms, has calculated, as the progeny of a single diatomaceous cell, the amazing number of one thousand millions in a single month. These facts are certainly calculated to awaken our astonishment, yet wonderful as they are as illustrations of the reproductive power, they are but a repetition of what actually occurs throughout the whole vegetable kingdom. Take for example the century plant of our conservatories. An excellent authority tells us that, shooting forth its flower-stalk at the rate of a foot in twenty-four hours, it actually produces no less than twenty thousand millions of cells in a single *day;* and many other plants, in a greater or less degree, illustrate the same fact. In both cases the new cells are microscopic, but while in the higher forms they remain aggregated to produce a close and compact structure, of a more or less limited duration, among the Diatoms the new cells become new individuals; and though, as *living* forms, their duration is brief, yet incorporating as they do into their tissues the almost indestructible element, silica, to a greater extent than in any other group of organisms, they become as it were *petrified*, even while still alive, and at death leave behind relics, minute indeed, but imperishable, the most perfect of fossils, in which every groove and marking of their former selves is accurately and beautifully preserved.

We have, then, only to reflect for a moment upon the almost universal distribution of the Diatomaceæ, to understand how, by rapid growth and the formation of indestructible remains, they may readily become of great importance in a physical and geological point of view. They are found alike in fresh, salt, and brackish water; in moist earth and in tidal muds; in hot springs and in river ice, from the poles to the equator, coloring vast tracts of the surface of the sea, as well as composing the great bulk of the ocean's bed. Even in the lava and cinders of volcanoes their presence has been recognized, and they form a large portion of the dust-showers and "blood-rains" formerly so dreaded, and which cover at times with powder the sails of ships at sea. Mr. Roper, an English microscopist, tells us, that, excluding coarse sand, one-fourth of the finer part of the residuum of the mud of the Thames is composed of the silicious remains of the Diatomaceæ, and expresses his belief that their silicious shells "have a perceptible influence in the formation of shoals and mud-banks." Dr. Hooker, again, in speaking of the results obtained by the Antarctic Expedition, observes that they abound in the newly-formed ice of the Polar Seas, producing by their death a submarine deposit of vast dimensions, occupying probably an area of 400 miles long by 120 wide, resting in part upon a glacier 400 miles in length, and in part upon the submarine flanks of Mount Erebus, an active volcano 12,000 feet in height! Finally, Ehrenberg considers that at Pillau, in Germany, "there are annually deposited from the water from 7,200 to 14,000 cubic metres of fine microscopic organisms, which, in the course of a century, would give a deposit of from 720,000 to 1,400,000 cubic metres of Infusory-rock or Tripoli-stone."

So much for the rapidity of growth and the physical importance of the Diatoms in our own era; let us now glance for a moment at earlier periods, and see whether these minute organisms were then too at work, producing results at all comparable to those which we witness at the present day.

To begin with the more recent geological epochs. Every tyro in microscopic inquiry has, among his other curiosities, obtained at least one slide with the label "Fossil Infusoria." These are Diatomaceæ, and the deposits from which they are derived may be found in all parts of our country, cropping out on the borders of ponds, or underlying layers of peat. It is, however, often a matter of doubt, especially in the former case, where the forms of the deposit and those still living in the water are apparently identical, how far these may really be entitled to the designation of "fossils." That they are so in many cases, and almost always when underlying beds of peat, is shown by the entire absence in these latter of certain species (especially *Nitschia* and *Synedra*), while these species are *growing* in the waters of the same locality in the greatest profusion. The period of the introduction of these species, then, must constitute one epoch in the geological history of the Diatoms, and more attentive study will yet reveal the occurrence of similar special epochs in the case of other species, even though we may not be able to directly synchronize these epochs with those determined from other data.* But leaving the region of uncertainty, there are numerous deposits, the great antiquity of which is placed beyond a doubt. Among these we may first enumerate a deposit in which were found imbedded, in 1843, the bones of a Mastodon, in Orange county, N. Y., and which, from its peculiar connection with these bones, was undoubtedly of contemporaneous origin. Being unaffected by severity of climate, it is probable that the Diatoms continued to exist through the whole Post-tertiary Period, affording, by the entire absence of marine species, another confirmation of the much-disputed Glacier theory of Professor Agassiz. Again receding, the next deposits of which the age may be considered as definitely fixed, are those of Virginia and Maryland, the most celebrated of all diatomaceous earths, from the extreme variety and beauty of their forms and the extent of the beds containing them. These beds, where they underlie the city of Richmond, are not less than twenty feet in thickness, and consist entirely of marine remains; while deposits, similar in character, and probably contemporaneous in origin, are found at many localities as far as Piscataway, in the State of Maryland. They are referred by their discoverer, Professor W. B. Rogers, to the Miocene Tertiary. One cubic inch of the earth has been calculated to contain not less than several millions of individual shells. Many similar deposits have been observed both in America and

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*For an interesting article on this subject, see a paper entitled "Some new and intermediate Forms of Diatomaceæ," by Dr. F. W. Lewis, in the Proceedings of the Philadelphia Academy of Natural Sciences, December, 1863.

Europe, but little has as yet been done in determining their precise age, or in accounting for the conditions necessary for the local accumulation of such vast quantities of material. Among the most remarkable in this respect are those of our western coast. I have now before me a block of pure diatomaceous earth, a foot and a half long by half a foot in depth, of chalk-like whiteness, sent by Mr. W. P. Blake, from Monterey (the entire weight of which is only about six pounds), and other similar beds are found at many points in Mexico, California, and Oregon. One of these, discovered by Colonel Frémont on the Columbia River, surpasses all other known deposits, being not less than 500 feet in thickness, and covered by at least 100 feet of compact basalt and other volcanic products!

It is probable that the Mexican and California beds, like those of Richmond, are of Tertiary age, though some of them may prove to be Cretaceous. That those of Monterey and San Francisco are far more ancient than the present physical features of California is proved by their being purely marine deposits, and by their differing wholly in character and species from other deposits, also of considerable thickness, from the eastern side of the Sierras, which I have lately had an opportunity of examining. These latter are fluviatile or lacustrine, and contain many species identical with those of the ordinary subpeat deposits of the Eastern States.

In passing from the Tertiary to earlier formations, the evidence of the existence of the microscopic Algæ becomes less evident, and for a long time none were believed to exist of more ancient date than those above alluded to. Certain peculiar organisms termed Xanthidia were, however, observed as of frequent occurrence in the flint-nodules of the chalk formation, and within a still more recent period similar forms have been observed in the analogous hornstones of the Devonian and Silurian ages, associated in this latter case with unequivocal Diatomaceous shells. As regards these Xanthidia, which have usually been regarded as remains of Desmids, it is certainly singular that, while all recent Desmids are purely fresh water, these should occur in marine deposits; and secondly, that, destitute as they are for the most part of the silicious shell of the Diatoms, they should occur in a fossil state at all. Yet the resemblance is certainly a striking one, and their occurrence with the kindred Diatomaceæ throws some degree of plausibility upon this belief. However this may be, the existence of one group at least of these organisms being established for these early periods, we can scarcely doubt that their numbers were as great then as in the seas of our own day, and that they have been present through all the great geological ages, even though metamorphism and other agencies have for the most part obliterated all traces of their beautiful but fragile shells. It is highly probable that accompanying the lower forms of animal life, these humble types of vegetation were among the first introduced upon the globe, performing then, as their representatives now do in the arctic seas and at great depths, where the higher forms of vegetation are wanting, the part of purifying the waters, as well as of contributing food for the sustenance of the different forms of animal life with which they were associated.

Thus we see that the lower no less than the higher forms of life have their appointed place, each fulfilling its own part, and each worthy of the admiration and the study of the observing mind.